

Enhancing Tree Seedling Supply to Smallholders in Leyte Province, Philippines: An Evaluation of the Production System of Government Nursery Sector and Support to Smallholder Tree Farmers

Nestor O. Gregorio · Steve Harrison · John Herbohn

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Abstract A decentralized seedling production is regarded as the most effective means of providing smallholders with planting materials. However, the sustainability of smallholder nursery operation is constrained by several factors, including the limited availability of germplasm, lack of technical skills and low seedling demand low viability of seedling market. The government nursery sector could complement the weaknesses of the smallholder nursery group but government nurseries are not operating effectively to enhance the availability of high quality seedlings of a wide species base for smallholder forestry. Seedling production in government nurseries is quantity-orientated with low emphasis on the production of high quality planting materials. Germplasm used in seedling production is mostly collected from unselected sources and seedlings produced are mostly of low physical quality. The species selection in government nurseries is heavily based on the availability of germplasm which resulted in the production of a few species which are commonly raised on private nurseries. The duplication of species of most seedlings raised in government nurseries with those produced in private nurseries and the far distance of government nurseries from the villages has resulted in low uptake of seedlings by smallholder tree farmers. For the government nursery sector to become more effective in providing support in the present paradigm of decentralized seeding production, a change from its production system and a broadening of the role it plays is needed. The social mobilization on seedling production as a scheme of implementing the Green Philippines Program has led the Department of Environment and Natural Resources to acknowledge the seedling production

N. O. Gregorio (✉)
College of Forestry and Natural Resources, Visayas State University,
Visca, Baybay 6521-A, Leyte, Philippines
e-mail: nogph@yahoo.com

S. Harrison · J. Herbohn
School of Natural and Rural Systems Management, The University of Queensland,
Gatton, Queensland 4343, Australia

activity of private individual and communal nursery groups. This can be an opportunity for organizing the private and government nursery sectors to promote the operational effectiveness of the overall forest nursery industry.

Keywords Social mobilization · Planting stock · Support measures · Nursery operational effectiveness

Introduction

Seedling availability is a bottleneck for any tree planting endeavour (Evans and Turnbull 2004). During the time when industrial forestry flourished, the bulk of seedlings used in establishing new trees in Philippine watersheds were mainly raised by forest concessionaires. Government-managed nurseries also acted as a major source of seedlings for government-initiated reforestation projects. Recently, however, the promotion of smallholder forestry, especially at the community level, is accompanied by transferring the seedling production to nurseries established by community organizations and private individuals. The decentralization of seedling production was envisaged to reduce the cost in transporting seedlings from the central nurseries to communities and to enhance the seedling production skills of smallholders. Further, production of seedlings in communities minimizes seedling damage during transport, which Sy (2001) argued is one of the reasons for the limited success of the government-initiated reforestation program.

While the shift towards a decentralized seedling production has been viewed as the most effective and efficient means of reaching smallholders with planting stock, this is not a straightforward management approach. Competent management skills of private nursery operators are needed (Shanks and Carter 1994), and assistance from the government sector and other support agencies including the provision of physical inputs and technical advice is imperative (Gregorio et al. 2007). Further, adequate monitoring and evaluation of private nursery operations to ensure operational effectiveness is necessary.

Shanks and Carter (1994) argued that in formulating programs and policies to supply seedlings to smallholder tree farmers, it should not be a case of exclusively choosing between a decentralized and a centralized nursery system. The most important consideration is how these nursery groups fit together in the overall nursery system. Offloading seedling production to community groups and private individuals has been proven to improve the access of smallholders to planting stock but the operation of centralized government nurseries is still necessary (Gregorio 2006).

This paper examines the role of the government nursery sector in relation to the promotion of small-scale forestry in Philippines, particularly in improving the availability of planting stock for smallholder forestry. While a number of government line agencies are involved in the production of forest tree seedlings, this paper focuses only the agencies in which the nursery operations greatly support smallholder forestry. In this context, only four agencies are considered, namely the Department of Environment and Natural Resources (DENR), the Department of

Agriculture (DA), the Philippine National Oil Company (PNOC) and the Visayas State University (VSU). Because the DENR is the government agency that is primarily involved in the production of forest tree seedlings, most of the discussion is focused on this particular agency. Background information of government agencies extending planting stock to smallholder tree farmers is presented to provide an overview of their seedling production operation. The seedling production system is examined and the policies of extending support to smallholder tree farmers are discussed. Policy implications are drawn and recommendations are presented to improve the operational effectiveness of the nursery industry.

Research Method

The research process involved four stages, namely pre-data collection activities, data collection, data analysis and drawing of conclusions from the results of data analysis. Activities that were carried out during the pre-data collection stage included the development of survey questionnaire, testing the questionnaires and selection of survey respondents. Data collection was carried out by personal interviews and focus group discussion with the nursery managers, assessment of seedling quality and gathering of secondary data from records. Data were organized and analysed using the Statistical Package for Social Sciences (SPSS) computer software package.

A semi-structured questionnaire was developed to elicit information concerning nursery cultural practices, the technical skills of nursery managers, nursery set-up, the volume of seedling production, nursery inputs and facilities, pathways of germplasm and seedlings, and constraints encountered in nursery operation. The questionnaire was tested by interviewing three selected representatives of the nursery operators. Aside from the interview, these individuals were asked for comments regarding the questions. Revisions were made to questions when deemed necessary and redundant questions were deleted, and final versions of the questionnaire prepared.

A total of 15 government nurseries from DENR, DA, VSU and PNOC were included in the survey. Personal interviews with the officers in charge of nursery operations were carried out, and observation and assessment of the nursery set-up and seedling quality was conducted in all nurseries. When available, three seedlings per species were used for destructive sampling to measure seedling quality parameters of sturdiness, basal diameter, total height, root-shoot ratio and root morphology, following procedures recommended by Jaenicke (1999). Any signs and symptoms associated with any disease were recorded and chemical analysis of the potting media was carried out. Further, secondary data pertaining to the seedling distribution records and programs of the government in support to small-scale forestry were gathered.

A focus group discussion (FGD) was conducted with all respondents after the nursery visits and interviews, to validate and confirm the data gathered during the survey. The FGD also provided an avenue for nursery managers to share their experiences, discuss their problems and formulate possible solutions. Issues that

were discussed include the problems encountered in operating the nursery, species availability and selection processes, germplasm pathways and extension mechanisms, assistance given to smallholders and possible alternative measures to improve the overall forest nursery industry in Leyte province.

Background of Government Agencies Involved in the Production and Distribution of Planting Stock to Smallholders

The Department of Environment and Natural Resources is responsible for the conservation, management, development and proper use of the Philippine environment and natural resources, including forestry. The DENR has a Region 8 office in the Leyte provincial capital of Tacloban, responsible for implementing national policies and planning, coordinating, monitoring and evaluation of DENR programs and projects in Leyte, Southern Leyte, Samar and Biliran. There is a Provincial Environment and Natural Resources Office (PENRO) in Tacloban. Three Community Environment and Natural Resources Offices (CENROs) fall under the PENRO, situated in the municipalities of Palo, Albueria, and Baybay, together with two sub-CENROs, in the towns of Carigara and Villaba. Seedling production is carried out at each of the three management levels of DENR offices (regional, PENRO and CENRO). The Operations Division of the regional office and the Forest Management Section of each CENRO is responsible for nursery establishment and seedling production.

The Department of Agriculture (DA) is the agency mandated for the planning and implementation of agriculture-related programs and projects of the government. It has offices both at regional and provincial levels as well as one in every municipality in Leyte province. Enactment of the *Local Government Code of 1991* transferred the responsibilities of some line agencies to Local Government Units (LGUs). The DA is one of the agencies that were subject of devolution; agriculture and fishery extension services of this agency were coursed through the LGUs, including the distribution of planting materials, particularly for agricultural crops. The production of forest tree seedlings is not a direct component of the DA-LGU program. The DA is primarily engaged in the production and distribution of planting stock for agricultural crops and fruit trees. However, it was realized by the agricultural technicians that farmers also require planting stock for timber trees. The demand from farmers for seedlings of forest trees has prompted some of the DA offices and LGUs to establish forestry seedling nurseries.

The electric power used in Leyte and neighbouring provinces emanates from the geothermal resources developed by the Philippine National Oil Company. The geothermal energy is taken from the 107,625 ha forest reservation in the watershed of Ormoc, Leyte, that is being developed and protected by PNOC. PNOC established a central nursery and produces a variety of forest tree seedlings. Seedlings raised in the nursery are not solely for use by community groups that were organized by the agency, but also for distribution to interested parties including LGUs, schools and private individuals within Ormoc and neighbouring

municipalities. Some of the seedlings are also utilized by the agency for their own tree planting needs.

The Visayas State University at Visca, Baybay, Leyte, is a government academic institution which is a centre of excellence in agriculture and forestry education in the Visayas region of the Philippines. Its mandate is to promote excellent education in agriculture, fisheries and forestry. The university activities focus on three key areas, namely instruction, research and extension. As part of the extension activities of the university, the College of Forestry and Natural Resources (CFNR) is extending technical advice on tree farming and supplying planting materials to various community groups and private individuals in Leyte Province. The CFNR has established a permanent nursery that produces a variety of forest tree seedlings of both exotic and native species. Aside from providing farmers with free planting stock, the seedling production of the college serves as an income-generating project for the university. Large volumes of seedlings are sold to buyers including private individuals, government agencies, private and public companies, and other interest groups. A proportion of the seedlings raised in the college nursery is also used for the tree planting and research activities of the university. The college maintains a 564.2 ha area of forest reservation which serves as the primary source of germplasm used in CFNR seedling production activities.

Support Measures Provided by the Government Nursery Sector to Smallholder Tree Farmers

All government nurseries were established to assist smallholder tree farmers. This support includes the provision of free germplasm¹ and seedlings to farmers, provision of technical advice, training to enhance the human capital of smallholders particularly on the aspects of seedling production and plantation management, and the provision of nursery materials. The DENR also distributes extension materials including flyers and manuals on forest nursery operation, and plantation establishment and maintenance.

The provision of seedlings and germplasm is the most commonly provided support to smallholder tree farmers. The distribution scheme varies among government agencies included in this study. The DENR requires the landholders to submit a letter of request to the local DENR office indicating the species and quantity of planting stock sought and the purpose of planting. This must be accompanied by a sketch map of the land where the seedlings are to be planted and a photocopy of the certificate of land title. According to the DENR, these documents are needed for record keeping so that growth and distribution of seedlings can be monitored to ensure that seedlings will be planted on titled land.

The requirement of proof of land ownership is not necessary in requesting planting stock from PNOC, LSU and DA but a request letter is needed. Seedlings are provided free of charge, but in a few DA nurseries seedlings are sold at a token

¹ Germplasm refers to wildlings and plant parts including seeds, leaves and branches used to produce a new planting material.

price because it has been observed that farmers do not place value to seedlings when they are given free. For all government nurseries, transportation of seedlings from the central nursery to farms is the responsibility of the smallholder tree farmers.

Training on nursery seedling production and plantation establishment is another form of assistance provided by the government nursery sector to smallholder tree farmers. Staff of support agencies including DENR and DA conduct training classes in communities. The usual strategy adopted to encourage a high attendance of local people during the training classes is to include community organizations. Accordingly, most of those who participate in training classes do so as members of community groups rather as private individuals. Funding limitation prevents the government nursery sector from intensifying their training activities in communities and conducting follow-up surveys to assess the adoption of technologies conveyed during training sessions.

Aside from training classes, the government nursery sector provides technical assistance to smallholders on nursery seedling production and plantation establishment. However, the provision of technical assistance is irregular, done only during training activities, casual contacts between smallholders and government nursery staff and when smallholders visit offices and nurseries of support agencies.

Nursery materials are occasionally provided by the government nursery sector to smallholder tree farmers to encourage seedling production. For example, free polybags are distributed to smallholders during training classes. Occasionally, a small amount of fertilizer is also provided to smallholders during training activities in communities. Reading materials including flyers and manuals on nursery seedling production are available at DENR and given to smallholders who visit their regional, provincial and community offices.

The Set-up and Production System of Government Nurseries

Nursery set-up is a factor that profoundly affects the operational effectiveness of nursery operation. In government nurseries, the species selection, nursery set-up as well as the location largely affects the uptake of seedlings by prospective end-users. Further, sources of germplasm and the type of labour employed to manage the nursery affect the quality of seedlings produced.

Seedling Production Scheme in Nurseries Established by the Government

The DENR, PNOC and LSU are largely producing seedlings of timber species while DA-LGU occasionally includes the production of seedlings of forest trees and agricultural crops. The seedling production of DA, VSU and PNOC are managed by full-time nursery staff. Additional labourers were sometimes hired from outside the agency especially at peak times of nursery operation, but in most cases all workers are regular employers of the agency. The provincial office of DENR has employed some students outside semester periods to work in the nursery. Aside from providing cash income, exposing the students to nursery work enhances their skills

in seedling production and helps them to appreciate the value of trees. In the DA-LGU nursery of Inopacan municipality, farmers were involved in tree seedling production. Interested farmers in the municipality were given space within the nursery to plant agricultural crops, mostly vegetables which they can harvest. In return, they were required to assist in nursery activities.

The seedling production in DENR is mostly conducted by independent contractors rather than agency employees. Most of the contractors were previously DENR staff members whose appointments were terminated due to lack of funds. Although contracted, the seedling production has been mostly carried out in government nurseries and a protocol has existed in handing over the seedlings to the DENR. Seedlings are assessed based on two main criteria, height and health; seedlings should have attained a height of 20–30 cm, and be free from pests and diseases.

Volume of Seedling Production by the Government Nursery Sector

The annual seedling production per government nursery based on the data generated from the survey ranged from 1,000 to more than 100,000 seedlings, but with 46.7% of government nurseries having a production of between 10,000 and 20,000 seedlings. Among the DENR offices, the regional office has the highest annual budget for seedling production. Table 1 reports the quantities of seedlings raised in DENR Region 8 nurseries and the species that were propagated. Notably, the

Table 1 Seedling production in various DENR offices from 1999 to 2007

Year	Office	Seedling quantity	Species
1999	Regional office	424,500	<i>S. macrophylla</i> and <i>G. arborea</i>
	PENRO Eastern Samar	121,700	<i>S. macrophylla</i> , <i>G. arborea</i> and dipterocarps
	CENRO Palo	20,000	<i>S. macrophylla</i> and <i>G. arborea</i>
	CENRO Maasin	61,750	<i>S. macrophylla</i>
2000	Regional office	161,388	<i>S. macrophylla</i> and <i>G. arborea</i> and fruit trees
	PENRO Eastern Samar	129,000	<i>S. macrophylla</i> and fruit trees
	CENRO Maasin	20,000	<i>S. macrophylla</i> and <i>G. arborea</i>
	CENRO Palo	30,000	<i>S. macrophylla</i> and <i>G. arborea</i> and fruit trees
2004	Regional office	153,400	<i>S. macrophylla</i> and <i>P. indicus</i>
	PENRO Samar	4,000	<i>S. macrophylla</i> and <i>G. arborea</i>
	CENRO Palo	10,000	<i>S. macrophylla</i>
	CENRO Baybay	10,000	<i>S. macrophylla</i>
	CENRO Albueria	8,011	<i>S. macrophylla</i> , <i>A. mangium</i> and fruit trees
2007	Regional office	50,630	<i>S. macrophylla</i> , <i>M. dubia</i>
	PENRO Samar	27,961	<i>S. macrophylla</i> , <i>G. arborea</i> and fruit trees
	CENRO Palo	6,000	<i>S. macrophylla</i>
	CENRO Baybay	10,689	<i>S. macrophylla</i>

Source: DENR Region 8 office file accessed August 2007

species are limited to few exotics—particularly *Swietenia macrophylla* and *Gmelina arborea*—and only one species of native tree.

Nursery Structure and Facilities

The survey found that most government nurseries were of permanent construction. Nursery areas were generally fenced and the nursery sheds were normally made of concrete and steel. Nursery facilities included water supply, well-structured seedling beds and nursery equipment including a soil sieve, sprinklers, backpack sprayers, germination trays, shovels and rakes. About 64% of nurseries used artificial shade materials to cover transplant beds, while others used natural shade from branches of overtopping trees. All nurseries had sufficient water supply. Tapping into a permanent water source was straightforward because government nurseries are situated in major towns where water systems are well established. All nurseries utilized transplant beds as hardening beds.

It was observed that sterilizing facilities were absent in almost all nurseries, which indicates that sterilization of germination media was not a common practice in government nurseries. Only the nursery in VSU has soil sterilizing facilities. It was also noted that none of the nurseries use screen trays to elevate the seedlings to facilitate root pruning and minimize the spread of pathogens. With the exception of the nursery at VSU, the seedlings were not elevated with the consequence that seedling roots penetrating into the ground. In the VSU nursery, transplant beds with concrete floors were constructed to eliminate this problem.

The regional nursery of DENR in the municipality of Palo has a greenhouse for clonal propagation, but this was used for research purposes only. Clonal propagation of forest tree seedlings was still not applied in large-scale seedling production by the DENR and in other government nurseries. Similarly, VSU has a permanent greenhouse but this was deemed not functional because the plastic roof that was supposed to be transparent has weathered, blocking considerable solar radiation from entering the structure.

The Location of Government Nurseries

Government nurseries were generally located within or close to major cities and towns. The choice of location of government nurseries is based on the availability of space and ease of supervision and maintenance. The proximity of nurseries to the potential users of seedlings is not given due consideration. Government nurseries are commonly situated next to the office of the establishing agency.

The distance of government nurseries from villages limits most of the smallholders from gaining access to seedlings. This could be one of the reasons why Emtage (2004) found that many smallholders produce their own planting stock instead of obtaining seedlings from government nurseries. DENR nurseries were situated in only four out of 41 municipalities in Leyte. Considering that there is a DA office in every town, DA-LGU nurseries are obviously more dispersed. However, not all of the DA nurseries produce seedlings of forest trees.

Tree Species Selection in Government Nurseries

The selection of species in government nurseries was based on two major considerations, namely the availability of germplasm and demand for the planting stock (Table 2). Other criteria were growth characteristics of the species, timber quality, and suitability to the planting site (which became a consideration when seedling production was for use within the agency).

The selection of tree species based on the availability of germplasm resulted in the production of seedlings in government nurseries that are also commonly raised in smallholder nurseries. Mahogany (*S. macrophylla*), Gmelina (*G. arborea*) and Narra (*P. indicus*) were found to be commonly produced in government nurseries, even though these are the dominant species raised in smallholder nurseries. These species are growing in relative abundance so smallholders mostly have access to them. Although demand for planting stock was identified as one of the prime considerations in the selection of seedlings to produce, it appears that the government nurseries fail to propagate many of the species preferred by the smallholders, which are also not available in smallholder nurseries. These preferred—but generally unavailable—species include a variety of premium timber species, for example dipterocarps, Narra (*P. indicus*), bagras (*E. deglupta*) and molave (*V. parviflora*).

Sources of Germplasm

Considering that the DENR, PNOC and LSU are producing a considerable volume of seedlings, germplasm was mostly collected from plantations. Germplasm is not collected from tree plantations with the intention of obtaining high genetic quality planting materials but rather is mainly due to germplasm abundance. Collecting germplasm from plantations reduces cost and time, in that a large volume of germplasm could be collected in one plantation during a single collection activity. The germplasm of indigenous species was mostly taken from naturally growing trees in the forest. Unlike DENR, PNOC and VSU, DA-LGU has a meagre monetary allocation for the production of forest tree seedlings. Few seedlings were produced by this agency at the time of the survey, and germplasm was commonly collected from trees growing near the nurseries

All officers in charge of government nurseries who were interviewed understood the importance of collecting germplasm from selected sources. Surprisingly,

Table 2 Primary considerations in selecting the species to be raised in government nurseries

Criterion	Number of times mentioned in the interviews (<i>n</i> = 15)
Availability of germplasm	14
Demand of planting stock	9
Timber quality and fast growth	6
Identified by supporting agency	2
Suitability to the planting site	2

Table 3 Mean sturdiness quotient and root-shoot values of sample seedlings from government nurseries

Species	Sturdiness quotient	Root-shoot ratio
<i>Acacia mangium</i>	13.8	0.16
<i>Pterocarpus indicus</i>	12.2	0.38
<i>Swietenia mahogany</i>	9.6	0.22
<i>Gmelina arborea</i>	7.9	0.50
<i>Dracontomelon dao</i>	6.6	0.43
<i>Securinega flexuosa</i>	8.6	0.64
<i>Samanea saman</i>	8.1	0.29
<i>Dipterocarpus kerrii</i>	7.1	0.84
<i>Terminalia microcarpa</i>	8.1	0.46
<i>Diplodiscus paniculatus</i>	8.0	0.67

however, only one out of 15 government respondents considered the appearance of mother trees in the selection of germplasm. Apparently, the mode of germplasm collection adopted by the nurserymen did not promote the production of high quality germplasm. As with smallholder nurseries, the normal practice was to collect whatever seeds are available. This suggests that even though the managers were knowledgeable about the benefits of using high quality germplasm, they were simply not concerned about this important aspect of seedling production.

High quality germplasm enters into the government nursery sector from supporting agencies, particularly through their foreign-funded projects. The supply is, however, not permanent and is difficult to manage because the germplasm comes from an external institution. In some cases, government nurseries accessed high quality germplasm from certified sources, but this was mostly used for research purposes.

Physical Quality of the Seedlings Produced

Given the technical skills of the managers of government nurseries, it was expected that seedlings produced by this nursery group would be of higher quality than those coming from smallholder nurseries. However, the measurement of sturdiness quotient² and root-shoot ratio³ of sampled seedlings revealed that these were of low physical quality (Table 3). All the seedlings had sturdiness quotients of greater than the ideal value which is 6.0, and every one had a root-shoot ratio of less than 1.0. This clearly indicates that the seedlings were lanky or etiolated.

Seedlings in government nurseries were closely stacked on beds and rarely graded according to height. The absence of grading could be identified as a factor that contributed to the lanky form of many seedlings. The managers knew the importance of this activity but lack of labour was pointed out as the reason why

² Sturdiness quotient is the ratio of the height of the seedling to the root collar diameter, which expresses the vigour and robustness of the seedling. The ideal value for a seedling to be considered sturdy is less than six (Jaenicke 1999).

³ Root-shoot ratio refers to the proportion of the root dry-weight to the shoot dry-weight. A root-shoot ratio between one and two is considered as optimal (Jaenicke 1999).

sorting and grading was not carried out. Further, the use of wildlings largely contributed to low root-shoot ratios. Seedlings appeared to have the appropriate height for planting but the root systems were still not well developed. This aspect was not given high priority in the seedling production of DENR, particularly with seedlings produced by contractors. The height and health of aboveground biomass were the only considerations in evaluating the seedlings before they were accepted by the DENR. Important characteristics including the root form and vigour were not included as seedling evaluation parameters. Given that contractors mostly grew wildlings to ensure seedlings of acceptable height standard at the end of the contract period, it was unlikely that development of root system would correspond to the seedling height, meaning that the seedling could be of appropriate height for outplanting but the root systems have not recovered from the stress during the collection process.

Examination of the root system of sampled seedlings revealed that root pruning prior to potting was not practiced in many government nurseries, which could be the reason for the commonly noted root deformities. About 69% of the sample seedlings were found to have deformed taproots, in the form of either J-rooting or root coiling. Aside from inappropriate potting, root coiling could also be attributed to the use of polybags especially when seedlings become overgrown. The roots will follow the contour in a round container, and turn up to one full circle before reaching the bottom. At the bottom, the roots will continue to elongate and may circle the container up to five times before reaching the drainage hole. As seedlings grow, a dense root mass will form, clustered at the bottom of the polybag. In the field, such seedlings often have limited lateral root elongation on the upper portion but a high concentration of root elongation from the lower part of the root system.

Impediments Experienced in the Operation of Government Nurseries

A number of factors constrain the effectiveness of government nursery operation, as indicated in Table 4. The shortage of funds was found to be the most important and the root cause of most of the other constraints. Although government nurseries generally have annual funds to carry out seedling production, nursery managers stated that the amount of money was too limited so they could not exercise ideal nursery practices for producing high quality planting stock in terms of either physical characteristics or genetic qualities. The amount of funds is too low for satisfying the target quantity of seedlings to raise using superior germplasm. Certified germplasm is expensive and cannot be sourced in the province of Leyte, hence germplasm was commonly collected from inferior and non-preferred sources. The lack of funds also hampered the production of seedlings of many species particularly those with germplasm that are in short supply such as those of a variety of native species. Because of limited funds, labour supply has also become a problem in government nurseries.

Lack of high quality germplasm was not frequently stressed by the managers of government nurseries although it was apparent that most of the germplasm used in government seedling production was taken from undesirable sources. This is

Table 4 Constraints that were commonly encountered by managers of government forest nurseries

Constraint	Number of times mentioned ($n = 15$)
Limited funds	10
Lack of labour supply	6
Lack of germplasm to diversify the production	5
Pilfering of seedlings (vandalism, stray animals, stolen)	5
Overgrown seedlings	5
Lack of skills	4
Lack of facilities	3
Lack of access to high quality germplasm	2
Low wages/low compensation	2

because the seedling production in government nurseries was quantity-orientated rather than focusing on the production of high quality seedlings. Most of the operators apparently did not view the limited access to high quality germplasm as a major impediment in nursery operation, considering that nurseries were not obliged to produce seedlings of high genetic quality.

The limited availability of funds also hampered the distribution of planting stock from the government nurseries. Inadequate fund prevents government nursery staff from transporting seedlings to villages. Transporting seedlings from central nurseries is necessary given the distance of government central nurseries to communities. Further, due to limited funds, little advertisement was carried out of seedling availability in government nurseries, which may have left smallholders unaware of the support that government nurseries extend to smallholder tree farmers and the species of seedlings available in government nurseries. None of the government nurseries advertised the availability of free seedlings other than by informing those who visited the nurseries to enquire about planting stock.

Despite the experience and high educational background⁴ of managers of most government nurseries, it could not be discounted that further knowledge on the propagation of several timber and fruit tree species is still required. Considering that the background of DA personnel is in the field of agriculture rather than forestry, more information about the propagation of a wide variety of timber species is urgently required among the managers of DA-LGU nurseries.

The Social Mobilization Program for Seedling Production

The Philippine government has recently launched the Green Philippines Program. This program affirms the commitment of the Philippine government towards the protection of the environment by implementing a four-point campaign, namely: reforestation, preservation of reefs and waterways, cleansing the land and air of

⁴ All in-charge of government nurseries have attended training sessions about nursery seedling production and completed four-year tertiary education.

toxic pollutants, and energy independence. The lead forestry initiative for this program is the Trees for Life Project. This project envisages the planting of 20 million trees in 2007. To ensure the availability of high quality planting materials in sufficient quantity at the appropriate period which is crucial for the success of the program, DENR offices in various regions of the Philippines have been directed to produce various quantities of seedlings to be used for the massive nationwide tree planting program. The seedling production, however, comes with a meagre budget which according to DENR personnel is definitely insufficient to produce the target volume of seedlings.

The DENR in Region 8 received a share of the seedling production responsibility to produce a total of 1.25 million seedlings in 1 year. Considering the limited funds to produce the required volume of seedlings, the DENR made the *social mobilization* initiative, involving the people in the seedling production activity. Private nursery operators, communal nursery groups, non-government organizations, local government units, government agencies and other interested sectors of the society have been encouraged to enjoin the seedling production activity. Support in the form of training and capacity building is provided to nursery operators but financial assistance is not indicated. The DENR provides germplasm to collaborating nursery operators, particularly private individuals and community organizations. Information on sources of high quality germplasm and technical advice on seedling production, plantation establishment and silvicultural techniques are also provided. A Memorandum of Agreement (MOA) has been executed between the DENR and sectors that agreed to carry out the voluntary seedling production.

With the intention of obtaining baseline information regarding the volume of seedlings that are readily available in every region of the Philippines, DENR offices conducted an inventory of existing nurseries. The inventory includes nurseries established by DENR, other government agencies, NGOs, community organizations, private individuals, and local government units. The inventory gathered information on name of nursery operators, location of the nursery, area of the nursery, seedling production capacity, volume of seedlings available and the species of seedlings raised. The result of the inventory shows a total of 388,320 seedlings from all nurseries of the region as of February 2007. This number falls far short on the required 1.25 million seedlings, which means that a considerable volume of seedlings still has to be produced.

Aside from the social mobilization on seedling production, DENR 8 made the initiative of voluntary seedling production. All DENR 8 personnel from the regional to the community level are doing voluntary seedling production work every Friday of the week. This activity aims to help meet the requirement for 1.25 million seedlings.

General Discussion and Concluding Comments

Government nurseries have advantages over smallholder nurseries primarily in terms of having access to sources of high quality germplasm, and having regular

funds to sustain the nursery operation and technical know-how on seedling production. Staff of government nurseries included in this paper have received forest nursery-related training or have tertiary education on forestry. Shanks and Carter (1994) indicated that a greater quantity of high quality seedlings can be produced in government than privately managed nurseries because production can be controlled and carried out by staff with technical knowledge of seedling production. While it is true that, in general, staff of government nurseries possess the necessary technical skills, the production of high quality seedlings in government nurseries is not always guaranteed. The survey data indicates that seedlings raised in the government nursery sector are generally of low quality.

Seedling production in the government nursery sector was found to be quantity-orientated and seeding quality was not given due consideration. In general, funds for seedling production were available but the budget did not consider the use of genetically superior germplasm. The available funds were insufficient to meet the required volume of production of genetically superior seedlings. As a result, germplasm was not acquired from certified sources of genetically superior materials. Instead, it was collected from trees of unknown provenances, of trees planted along roads, in parks and in school grounds. Although the Philippine government nursery sector has high access to producers of genetically superior germplasm from domestic sources, the flow of high quality germplasm from certified sources is not well established.

Aside from budgetary constraints, the lack of concern of the nursery staff in ensuring the collection and use of genetically superior planting materials is a contributing factor for the government nursery sector not using genetically desirable germplasm. It was noted that even for species where there is an abundant supply of germplasm, as in the case of some exotics, the collection was still undertaken in a haphazard way and the physical traits of the mother trees and the distances between them were not considered. According to Wightmann (1999); Mulawarman et al. (2003) and Jones (2004), the physical traits of mother trees are straightforward indicators of the future phenotypic characteristics of the seedlings.

The use of wildlings together with small seedling containers has clearly contributed to the commonly observed root deformation of the seedlings that were propagated. This was evident particularly in DENR nurseries where wildlings were heavily used by seedling production contractors. Staff of government nurseries and seedling contractors obviously understood the need of carrying out root pruning but this activity seemed to be ignored. According to some of the staff in charge of nurseries, root pruning was only conducted when the seedling to be potted had a lignified taproot that could not be easily accommodated in the polybag.

There was no definite schedule during which seedlings could be taken from government nurseries, particularly those that were for free distribution and not for use of the agency. The use of polybags has adverse impact on seedling root system development as seedlings stay longer in the nursery. Examples of malformed root forms due to use of polybags are root coiling and J-rooting. This pattern of root development could reduce the potential survival, growth and mechanical stability of the planted trees. Recognizing this risk to the future field performance of the seedlings as a result of using polybags and the fact that seedlings are usually not

utilized on time, there is a need to refrain from using polybags and shift to some alternative seedling containers such as hiko trays. There has been a number of reports highlighting the benefits of using hiko trays over polybags including those of Carter (1987); Jaenicke (1999); Wightmann (1999) and Cedamon and Emtage (2005).

The seedling production in government nurseries surveyed was limited to a narrow species base. Seedlings that are commonly propagated in government nurseries were also commonly raised in the smallholder nursery sector. The duplication of species raised in effect makes the government nursery sector less responsive to the species demanded by the local people. This finding supports the claims of Robinson and Thompson (1987), Shanks (1992) and Shanks and Carter (1994) that whenever the species available in government nurseries are similar with those that smallholders can produce readily, the smallholders would not feel motivated to travel and obtain seedlings from the government central nursery. Given that the option for farmers who would like to obtain planting materials from government nurseries is dependent on what is being raised in these nurseries, the species selection should be responsive to the species needed by the farmers (Barnard and Foley 1984).

The access of smallholders to seedlings which are given free of charge from government nurseries is hampered primarily by high transportation costs. Government nurseries are situated far from many communities, thus only those living close to the nursery area and those having the resources to transport the seedlings have benefited from this support. DENR nurseries are producing the highest volumes of seedlings for distribution to smallholders; however, these nurseries are not well-distributed across Leyte province. The DA has offices in each municipality of the province, which is potentially useful for seedling distribution but this agency is not primarily concerned with the production of forest tree seedlings. Given the distribution of DA nurseries, one option for facilitating the distribution of seedlings would be to reorganize the seedling production and distribution system to utilize the DA offices as a conduit for dissemination of seedlings to smallholder tree farmers.

In the light of budget austerity experienced in the government nursery sector in which the volume of seedling production has been reduced, it is apparent that government nurseries could not completely satisfy the demand of smallholders for planting stock. Accordingly, smallholder nurseries have a crucial role to play in providing the planting stock to the wider smallholder tree farming community. However, the government nursery sector still has a vital role in promoting smallholder forestry, although decentralized seedling production is deemed as the best alternative. Despite limited funds, government nurseries are always operational. Consequently, the operational status of government nurseries is more stable compared to smallholder nurseries. The government nursery sector may, therefore, serve as a back-up in case of the failure of smallholder nurseries. Staff members of government nurseries generally have a high level of technical expertise which is important for providing technical assistance to smallholder nursery operators. Government nurseries have the skills to carry out research activities that would help the smallholders improve the effectiveness of seedling production. Further, unlike smallholder nurseries, the government nursery sector has greater access to sources of genetically superior germplasm.

With the attributes of the government nursery sector that would complement the shortcomings of smallholder nurseries, the existence of government nurseries in the present paradigm of decentralized seeding production is indeed necessary. However, for the government nursery sector to become more effective in providing support to the smallholders, a change from its production system and a broadening of the role it plays is necessary. The social mobilization on seedling production as a scheme of implementing the Green Philippines Program has forced the DENR to acknowledge the location and seedling production activity of private and communal nursery groups. This could be an opportunity for organizing the private and government nursery sectors, promoting a harmonized collaboration to complement the weaknesses of each group so as to promote the operational effectiveness of the overall nursery industry.

The social mobilization program of the DENR emphasizes the provision of technical support but it does not provide financial assistance to private nursery operators. Experience shows that financial assistance or monetary returns is the bottleneck to the sustainability of most people-based resource management projects in the Philippines (Estoria 2004). Accordingly, there is a need to include support that would result in greater economic viability of the private and communal nursery sectors.

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